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# Request for grant of a patent

*(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)*

The Patent Office

Cardiff Road
Newport
Gwent NP9 1RH

1. Your reference — GW-30846

2. Patent application number
*(The Patent Office will fill in this part)* — 0104785.1 — 27 FEB 2001

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

**Pace Micro Technology Plc**

**Victoria Road**
**Saltaire**
**Shipley**
**BD18 3LF**

27FEB01 E609282-6 D00346
P01/7700 0.00-0104785.1

7588569001

**England**

Patents ADP number *(if you know it)*

If the applicant is a corporate body, give the country/state of its incorporation

4. Title of the invention — **MPEG Decoder Video in the form of Cue and/or Review Streams of Data**

5. Name of your agent *(if you have one)*

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

**Bailey Walsh & Co.**

**5, York Place**
**Leeds**
**LS1 2SD**

Patents ADP number *(if you know it)* — **224001**

6. If you are declaring priority from one or more earlier patent applications, give the and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

| Country | Priority application number *(if you know it)* | Date of filing *(day / month / years)* |
|---|---|---|

7. If this application is divided or otherwise derived from an earlier UK application, the earlier application

| Number of earlier application | Date of filing *(day / month / years)* |
|---|---|

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer "Yes" if:*

*a) any applicant named in part 3 is not an inventor, or*

*b) there is an inventor who is not named as an applicant, or*

*c) any named applicant is a corporate body*

*See note (d)*

**Yes**

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document.

| | |
|---|---|
| Continuation sheets of this form | |
| Description | 7 |
| Claim(s) | |
| Abstract | |
| Drawing(s) | 1 + 1 |

10. If you are also filing any of the following, state how many of each item.

| | |
|---|---|
| Priority Documents | |
| Translations of priority documents | |
| Statement of inventorship and right to grant of a patent *(Patents Form 7/77)* | |
| Request for preliminary examination and search *(Patents Form 9/77)* | |
| Request for substantive examination *(Patents Form 10/77)* | |
| Any other documents *(Please specify)* | |

11. I/We request the grant of a patent on the basis of this application

Signature

Date **26.02.01**

12. Name and daytime telephone number of person to contact in the United Kingdom

**G Wood**
**0113 2433824**

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# MPEG Decoder Video in the form of Cue and/or Review Streams of Data

The invention which is the subject of this application is related to the provision of broadcast data, from which television programmes and other services, such as home shopping, games, internet services and the like can be generated, and particularly to the provision of streams of data as "trick mode" streams of data.

Increasingly the provision of digital broadcast data by service providers is being used to provide to users a range of services. The broadcast data is received by a Broadcast Data Receiver (BDR) at the users premises and the BDR decodes the encoded data and generates video and/or audio as appropriate. Although reference is herein made to the invention with respect to a BDR it should be appreciated that the same is applicable to other apparatus which possess video data such as, for example, DVD players.

There are many different forms of user selectable services and one of these is known as Video on Demand (VOD) in which the user can select to view a programme or film at that instant, rather than being bound by any particular schedule.

In a video-on-demand service, which is typically defined as a "single-user service" for the specific user, the user can be presented with the opportunity to request that the MPEG format stream of data is presented in fast cue/fast review form. This is typically achieved via a method whereby the video data server in or connected to the BDR delivers an MPEG stream of data containing no audio, and containing some or all of the I-

frames from the video (an MPEG video stream will typically contain an I-frame every half second or so).

The I frame of data is provided to allow for service data acquisition and for error recovery purposes, and importantly, can be decoded entirely without reference to adjacent frames of data.

However a problem arises from the fact that at the transition between the normal stream of data and the fast cue/fast review, hereafter referred to as the trick mode stream of data, it is necessary to flush the video decoder buffer memory in the BDR in order to avoid decoding and/or frame re-ordering errors. As is the case at the start of playing a normal stream of data, the BDR processing means is required to go through a phase of pre-filling the video buffer memory with data before decoding of the trick mode stream of data can commence. However, unlike a normal stream of data the BDR has no access to header fields "bit_rate" and "vbv_delay" data from the video stream to determine the pre-fill threshold, because the International Standard ISO/IEC 13818-1 defines this data to be invalid in the case of trick mode streams of data.

A typical approach may be to generate an amount of data for the buffer equal to "vbv_buffer_size", which is a header field that is still valid for trick mode streams of data, but in practice it has been found that this can lead to relatively large time delays of a second or so before the user sees the trick mode stream start, especially if the bitrate of the original stream is somewhat below the defined maximum for the MPEG data profile/level.

The aim of the present invention is to provide a method which leads to the MPEG decoder and hence BDR appearing to be

much more responsive at the transition point between normal streams of data and the trick mode stream of data.

In a first aspect of the invention there is provided a method for generating a trick mode stream of data for the generation of a video display said method, at the commencement of the trick mode, including the use of a direct measurement of the separation of encoded pictures in the video data bitstream to replace the use of various header fields which would be used in a normal MPEG data stream, but which are defined by MPEG to be invalid in the case of trick mode streams of video data and the use of timestamp information in the bitstream of data to complete the measurement.

In one embodiment, in a first step of the method of the probable buffer size of the I frame of data in the trick mode data stream is determined.

When determined, the video buffer memory occupancy requirement to avoid delay in the transition between normal and trick mode video data streams is set at or substantially at the level required to accommodate data for the determined size of I frame.

The MPEG format stream of data comprises a number of hierarchical levels, one of which is the systems layer and in which layer is included data referred to as time stamp data which basically acts as information to allow data in other levels to be time synchronised and from time to time resynchronised with respect to the time stamp data.

In a preferred embodiment the method includes the use of the time stamp data to estimate the size of the I frame and hence

the required video buffer memory occupancy requirement. By using the time stamp data so the need to directly determine the amount of data in the single compressed frame can be avoided.

Thus the invention relates to the use of a direct measurement of the separation of encoded pictures in video data bitstream to replace the use of various header fields which would be used in a normal MPEG data stream, but which are defined by MPEG to be invalid in the case of trick mode streams of video data and the use of timestamp information in the bitstream of data to complete the measurement.

Specific embodiments of the invention are now described with reference to the accompanying figures; wherein

Figure 1 illustrates Video Buffer prefill level obtained in accordance with the conventional approach using vbv_buffer_size data; and

Figure 2 illustrates Video Buffer prefill level obtained in accordance with the invention.

The I-frames in an MPEG video stream are usually compressed down to fairly uniform sizes, identical to within a few percent. This means that the video buffer occupancy will not vary greatly from frame to frame, and so the first part of the method of the patent application is that the compressed size of the first frame encountered in the trick mode data stream can be used to set and determine the buffer occupancy requirement to be satisfied before each and every picture frame decode is initiated to generate the video display. However, to directly determine the amount of data in a single compressed MPEG frame can still be a fairly intensive operation, so the second aspect of the

method of the application is to use the quantised nature of the timestamp data in the systems layer of the MPEG stream to efficiently estimate the size of the first frame, and therefore the required pre-fill threshold.

For a normal stream of data, it is irrelevant to calculate how much data is required for the video buffer occupancy and hence should be buffered up before the first picture is decoded as the "vbv_delay" data from the picture header data in the MPEG format data stream gives the length of time that the start of the data for the picture should spend in the buffer before it is decoded. By multiplying this by the "bit_rate" field from the sequence header data the required threshold value is obtained. However, for trick mode (fast cue/review) video data streams, neither the "vbv-delay" nor the "bit_rate" data can be used in accordance with International Standard Compliance requirements (see ISO/IEC 13818-1 section 2.4.3.7, under the description of "trick_mode_control").

This conventionally has been interpreted as leaving the only option for such streams of data to be to wait for the buffer to reach the "vbv_buffer_size" specified in the sequence header data. Although this is a safe option, in as much as it is guaranteed that taking this approach will never lead to the buffer memory under-running, and hence the video generated being stopped it does have the drawback that it is difficult for video data encoders to accurately determine the appropriate value for "vbv_buffer_size" for a given stream. Because of this it is found that the encoder is typically set to have the "vbv_buffer_size" value at the maximum level allowed for the MPEG profile and level. This is often a gross exaggeration, especially for lower bitrate data streams, and it can lead to unacceptably long delays between the start of the streaming of

trick mode streams and the display of the first decoded video picture, as illustrated in Figure 1 where it is shown with the vbv_buffer_size value at maximum, the initial buffering time 2 is much greater than that subsequently required 4 for each frame. Furthermore, because at any one time, there is data for several pictures in the buffer due to its size, it can also lead to the failure to decode a noticeable number of pictures at the end of the trick mode stream when the buffer is flushed in preparation for return to normal play mode.

This application sets out an alternative scheme, based upon the observation that MPEG encoders tend to generate I-frames of remarkably consistent sizes, usually within a few percent of each other. This, in conjunction with the fact that for trick mode data streams, it is permissible for a decoded frame to be displayed repeatedly until the next frame is ready to be decoded, allows the design of a buffering scheme, as illustrated in Figure 2. This shows how a wait for the picture start code of the "next" picture to enter the buffer can be used and performed before decoding the data for the "current" frame or picture.

However, parsing the video stream in this way can be a relatively intensive task, so there are two steps taken to improve the situation:

1) Use the fact that I-frames are uniform in size, and hence only perform the wait operation once, at the beginning of the trick mode data stream, and add a small percentage on to the measured frame size to allow for variation from frame to frame.

2) Determine the start of frames from the systems layer data, by monitoring the PTS's (presentation time stamps) in the PES packet headers. Because the PTS's are quantised in steps of

one frame, then as soon as the PTS is seen to change, it is deduced that the payload of the PES data packet refers to the next frame along.

In practice, encoders tend to encode a PTS for each frame, but just in case one is encountered that doesn't, a decoder can be designed to use the vbv_buffer_size as a fallback threshold, for the buffering time requirement.

One specific example is; a typical clip is as follows: Main profile at main level, so vbv_buffer_size is 1835008 bits Original bitrate 3 Mbits/s Frame rate is 30 frames/s Every 15$^{th}$ frame is coded as an I-frame Mean I-frame size is 276720 bits (standard deviation 4%). If we generate a x2 cue trick mode stream using only the I-frames from this stream, then the actual bitrate is 4*276720 = 1106880 bits/s. Time to reach prefill threshold using conventional vbv_buffer_size algorithm: 1835008/1106880 = 1.66 seconds Time to reach prefill threshold using the method of the invention: 276720/1106880 = 0.25 seconds.

Thus the method of the present invention allows a faster response to cue/review commands in a video-on-demand system and also, when the decoder returns from a trick mode stream to normal play, a "cleaner" transition can be accomplished and hence improves the appearance to the user.

**Prefill level obtained from vbv_buffer_size**

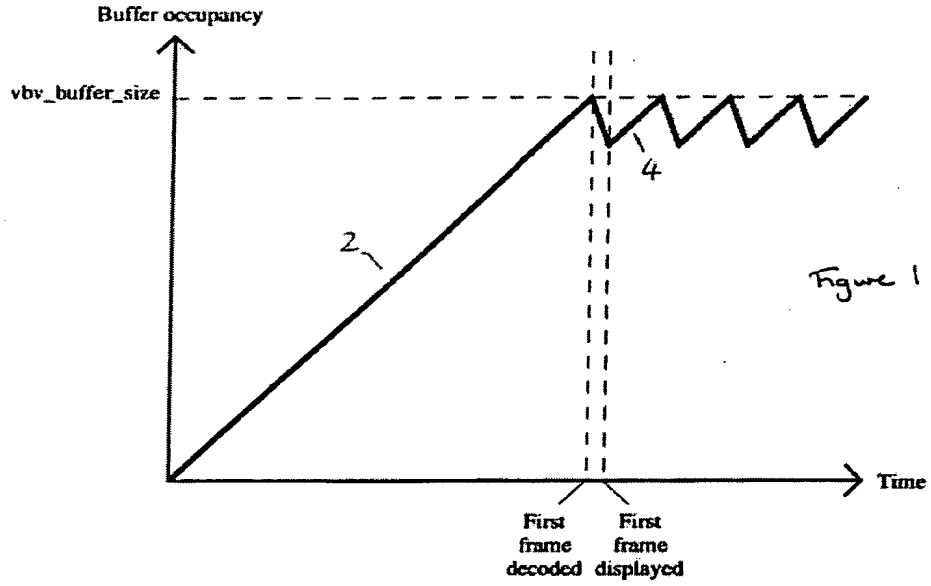


Figure 1

**Prefill level obtained from frame separation**

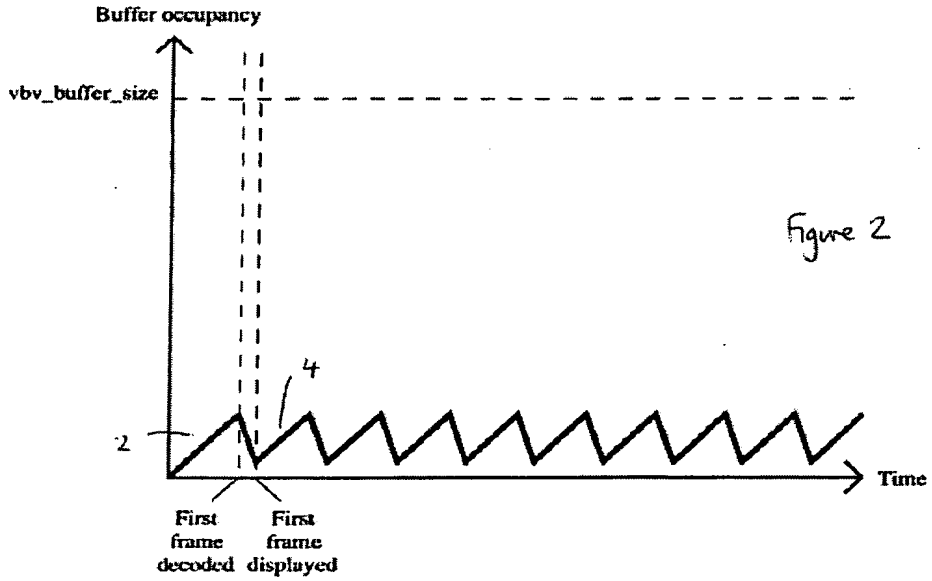


Figure 2